THE DEPARTMENT OF ENERGY AND THE U.S. GEOTHERMAL ENERGY PROGRAM

Cliff Carwile
Department of Energy, Division of Geothermal Energy

United States

ABSTRACT

U.S. geothermal resources are classified according to resource type and estimates of these resources are presented under the categories of (1) maximum resource base, (2) technically recoverable resources, and (3) economically available resources. The objective of the federally funded geothermal program is to accelerate commercial, i.e., non-federal, development of all types of geothermal energy through resource assessment, leasing of federal lands, demonstrations of various types, loan guaranties, and technology development.

The governmental departments and agencies participating in the U.S. geothermal programs are identified and the program of the Department of Energy, the lead agency, is outlined. U.S. geothermal development and utilization goals are also discussed. The past, current, and proposed funding levels of the DOE program and the rationale for these expenditures are summarized.

DISCLAIMER

U.S. geothermal resources have been classified into three types:

Hydrothermal - including both liquid-dominated and vapor-dominated resources. Most of the U.S. geothermal resources are liquid-dominated, the best known example being the hydrothermal reservoirs in the Imperial Valley of California. The only proven vapor-dominated system in the U.S. is at The Geysers field in northern California where approximately 1,000 MWe are generated.

Geopressured - high pressure, moderate temperature aquifers of the Texas-Louisiana Gulf Coast Region. Here at depths greater than about 12,000 feet, high pressure, comfined aquifers contain dissolved methane as well as thermal energy.

Hot Dry Rock - the resource is thermal energy contained in the crystalline rock. Definition excludes hydrothermal resources.

The maximum resource base, the amount technically recoverable, and the amount economically available is presented in Table 1.

The figures for hydrothermal (liquid-dominated) and geopressured resources are from USGS Circular 790. The USGS considers an assessment of hot dry rock resources to be premature and the 5,000,000 Quads was estimated by the Los Alamos Scientific Laboratory and has been used a number of times by the Department of Energy's Division of Geothermal Energy.

For comparison, the total gross energy use in the United States in 1979 was approximately 78.8 Quads. Total electrical energy production from geothermal resources in the U.S. is approximately 1,000 MWe with vertually all of that from The Geysers field in California. In addition, there is a small amount of electric power being produced by Union Oil and Southern California Edison in the Imperial Valley from hydrothermal resources. The amount of direct use applications is negligible at the present time.

The objective of the federally funded geothermal program is to accelerate commercial, i.e., non-Federal development of all types of geothermal energy through resource assessment, leasing of Federal lands, demonstrations of various types, loan guaranties, and technology development. By law the U.S. geothermal program is coordinated by the Interagency Geothermal Coordinating Council (IGCC), a group of Federal agencies with responsibilities and interests in geothermal energy. Obvious members are the Department of Energy, the Department of the Interior, and the Environmental Protection Agency. Other members include the Departments of Treasury, Agriculture, Housing and Urban Development, Defense, and Commerce. The Department

of Energy is the lead agency and plays an agressive advocacy role. Its annual geothermal budget of 150 million dollars is much larger than that of all of the other agency geothermal budgets combined.

As vital as the roles of these other agencies are to U.S. geothermal development I will discuss briefly only the Department of Energy's program.

The program predates the formation of DOE in October 1977 and traces its orgins to projects first initiated in the National Science Foundation and the Atomic Energy Commission prior to 1975. Those projects were transferred to the new Energy Research and Development Administration in February 1975, and combined under the Division of Geothermal Energy. The current organizational structure of the Division (Figure 1) consists of the Director's Office four line branches, and a program coordination branch. Dr. John Salisbury is the Acting Division Director and Clifton Carwile is the Acting Deputy Director. Lachlan Seward, the Loan Guaranty Officer, oversees the program whereby the Federal Government guaranties commercial loans for geothermal development.

The four operating branches are the Advanced Energy Systems Branch, Geothermal Industrialization Branch, Geosciences Branch, and the Hydrothermal Technology Branch.

The Advanced Energy Systems Branch has responsibility for the Geopressured Resource, Hot Dry Rock, Drilling and Completions Technology Development, and Reservoir Stimulation Programs. The Baca 50 MWe flash steam demonstration and the planned Heber 50 MWe binary plant are under the Hydrothermal Industrialization Branch. The Hydrothermal Technology Branch covers materials development, corrosion research, environmental control technology, advanced logging instrumentation, and energy conversion.

The current Fiscal Year 1981 budget totals 151 million dollars for geothermal research and development and $43M for the Geothermal Loan Guaranty Program (Figure 2). Of the total R and D Budget $7.75M is devoted to drilling and completions technology development. The Sandia program is the largest part of that effort. The geothermal R and D Budget has remained essentially unchanged at 150 million dollars for the last three fiscal years but has increased more than five fold since 1975 (Figure 3). The transition quarter shown reflects the three month period when the U.S. government changed from a fiscal year beginning July 1 to one beginning October 1. The hope was that such a change would prevent the annual funding crises that many U.S. government agencies had been prone to. However, it has not helped much in that most agencies as of late November still did not have their annual appropriations and were operating under continuing resolution of the Congress.

These are large amounts of money even in these times of inflated dollars and the DOE must have a rationale for its expenditure of 680 million dollars over the last six years and its hopes for at least

that much in the next five years. The rationale (Figure 4) is that:

- o Geothermal industry is in its infancy
- o The resource base is largely unconfirmed
- o Economics are marginal for liquid dominated hydrothermal, dubious for geopressure, and unconfirmed for hot dry rock
- o Technology deficiencies
- o There are nontechnical barriers erected by local, state, and Federal entities to be resolved
- o Financial risks are perceived, perhaps unfairly, to be high
- o Geothermal energy can contribute significantly to near-term energy supply for the U.S.

Geothermal energy could displace fuel oil and natural gas in electric power generation, space heating, and process heat uses. If eventually proven to be economic, methane production from geopressured resources could increase domestic supplies of natural gas. Geothermal energy could also be of use in establishing an alcohol fuels industry in this country. Any new domestic energy source; such as geothermal, can contribute to diminishing the U.S. balance of payments problems, reduce the requirement for foreign oil, and indirectly contribute to the security of the U.S. and other nations.

How is geothermal development progressing in the U.S.? It is estimated that geothermal power plants under construction and planned will result in approximately 2,600 MWe on-line by 1985 (Figure 5). Virtually all of this would be from The Geysers and the Imperial Valley. The IGCC goal for 1990 is 7,000 MWe while a business-as-usual approach, without a continued Federal program, would lead to only 4,000 MWe. These estimates are for hydrothermal geothermal resources only since the economics of both geopressured and hot dry rock resources are considered to be too uncertain to hazard any estimate of future development. The IGCC goals for the year 2000 are 25,000 MWE and 1 Quad of direct heat energy. Recent market penetration studies conducted by the Department indicated that these are ambitious but certainly attainable goals.

The two main barriers to <u>forecasting</u> higher utilization goals for geothermal energy in the future are the assumptions that the U.S. energy picture will not change dramatically and for the worse in the foreseeable future and that the finding and confirmation rate of new reservoirs will not support attainment of much higher goals by the year 2000. I think the first assumption is in error and that that will eventually take care of the second but in the meantime the U.S. will have lost a lot of valuable time.

Table 1

U.S. Geothermal Resources Estimates

(In Quads = 1.055 X 10^{18} Joules)

	Maximum Resource Base	Technically Recoverable Resource	Economically Available for Utilization
Hydrothermal 1/	9,000	2,300 2/ 660-1,200 3/	350-400 85-140
Geopressured 1/			
Thermal	100,000	40-4,000	30-300
Methane	60,000	150-1,500	75-800
Hot Dry Rock	5,000,000	3,000-20,000	200-2,000

1/ Hydrothermal resources, liquid dominated, and geopressured resources estimates from USGS Circular 790.

2/ Above 90°C.

3/ Above 150°C.

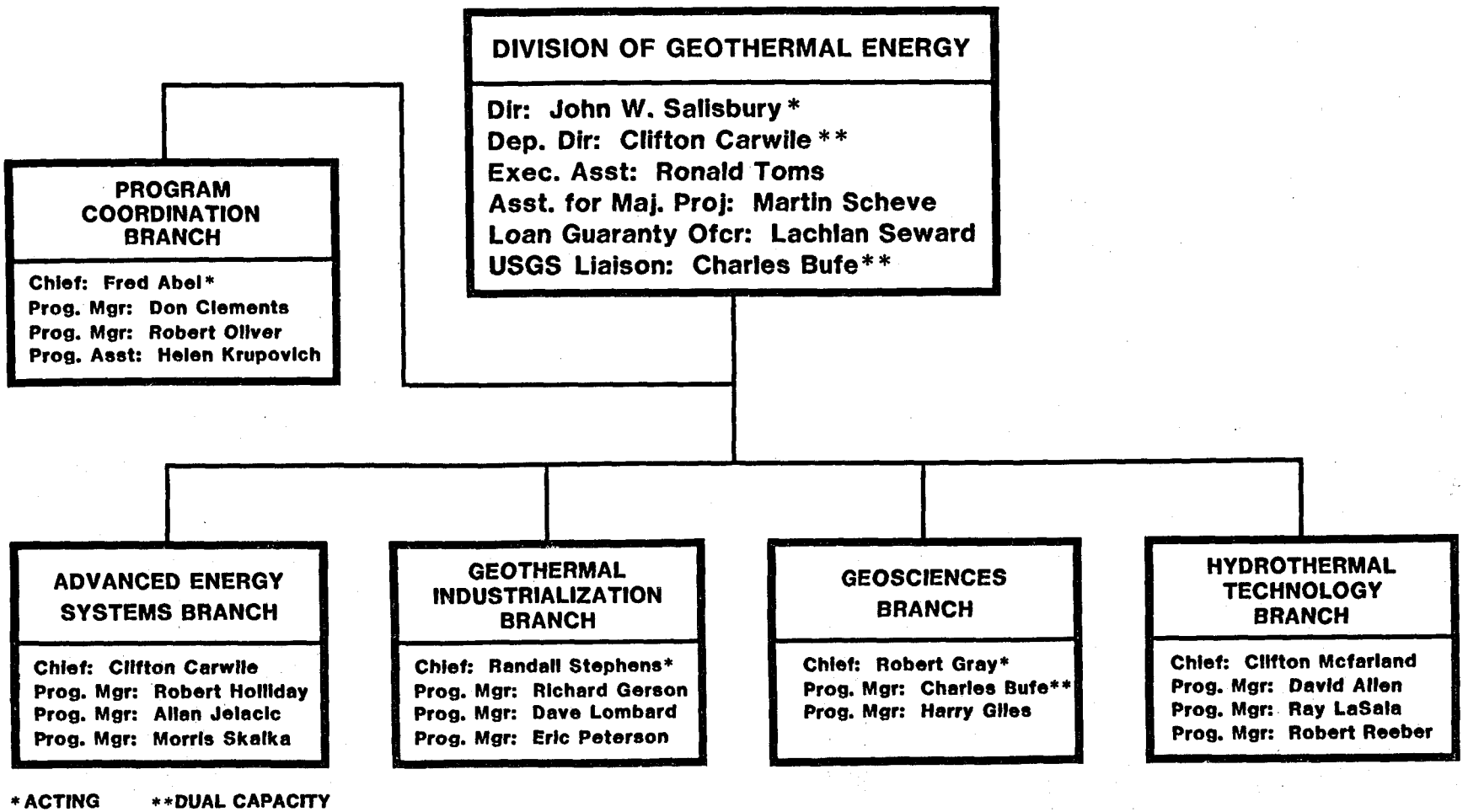

Figure 1. U.S. Department of Energy Division of Geothermal Energy

BUDGET CATEGORY	DOLLARS IN MILLIONS
GEOTHERMAL ENERGY R&D	
HYDROTHERMAL INDUSTRIALIZATION	66.0
GEOPRESSURED RESOURCES	34.5
GEOTHERMAL TECHNOLOGY DEVELOPMENT	48.1
COMPONENT DEVELOPMENT	
HOT DRY ROCK	
PROGRAM DIRECTION	2.4
	151.0
GEOTHERMAL LOAN GUARANTY	
LOAN RESERVE	43.1
PROGRAM DIRECTION	0.2
	43.3

Figure 2. U.S. Department of Energy FY 1981 Geothermal Budget

	FUNDING IN THOUSANDS OF DOLLARS
FY 1975	28,100
FY 1976	30,718
TRANSITION QUARTER	13,656
FY 1977	50,807
FY 1978	103,470
FY 1979	151,048
FY 1980	150,424
FY 1981	151,021

Figure 3. Geothermal Research, Development and Demonstration Funding History

- GEOTHERMAL INDUSTRY IN ITS INFANCY
- LARGELY UNCONFIRMED RESOURCE BASE
- MARGINAL ECONOMICS
- TECHNOLOGY RD&D NEEDS
- INSTITUTIONAL BARRIERS
- PERCEIVED FINANCIAL RISKS
- SIGNIFICANT POTENTIAL FOR NEAR TERM ENERGY SUPPLY

Figure 4. Geothermal Energy Rationale for a Federal Role

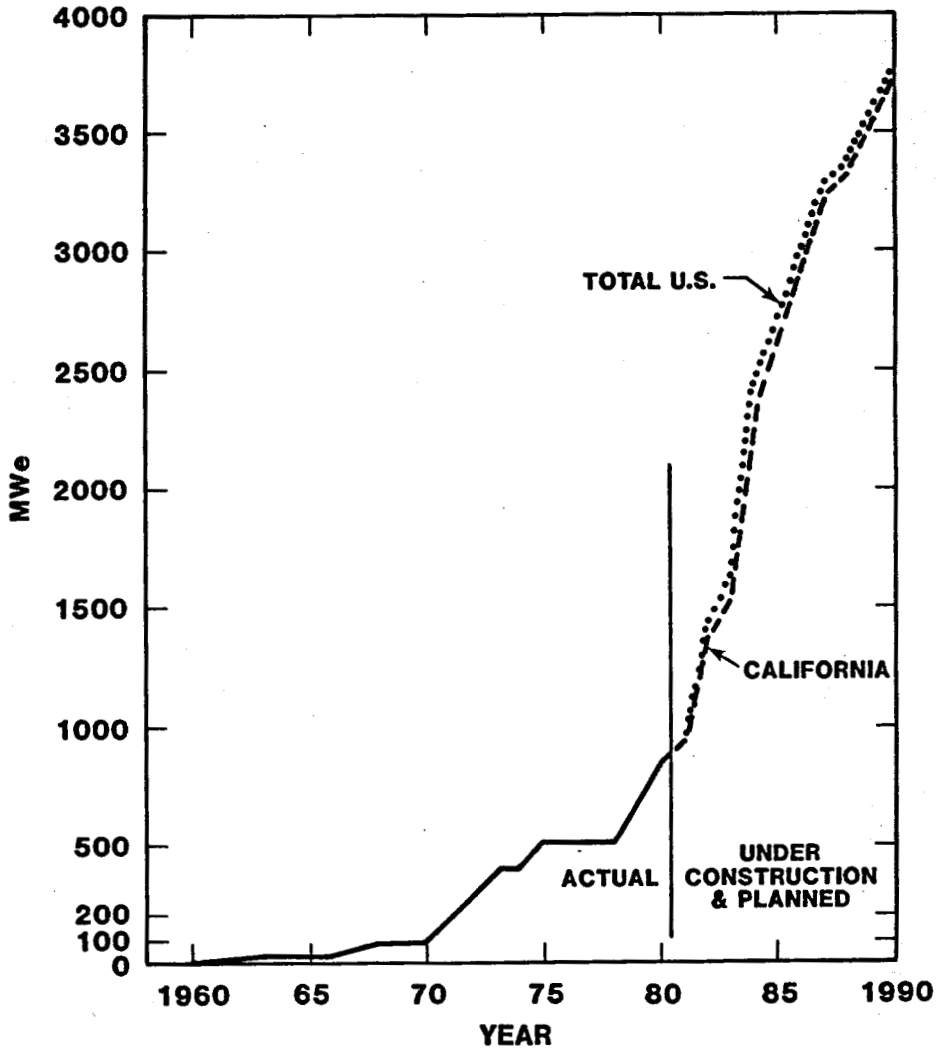

Figure 5. Electric Power On-Line in U.S. and California by Project Completion Date